

CLAIMS

What is claimed is:

5 1. A catalyst suitable for use in hydrocarbon conversion, said catalyst comprising: at least one porous macrostructure comprised of: (a) a three-dimensional network of self bound particles of porous inorganic material; and, (b) at least one metal, said particles occupying less than 75% of the total volume of said at least one macrostructure and being joined together to form a three-dimensional interconnected network of pores.

10 2. The catalyst recited in Claim 1, wherein said porous inorganic material is comprised of molecular sieve.

15 3. The catalyst recited in Claim 2, wherein said network comprises pores having diameters greater than about 20 Å.

20 4. The catalyst recited in Claim 3, wherein said porous inorganic material is a large pore or intermediate pore size molecular sieve.

25 5. The catalyst recited in Claim 4, wherein the structure type of said molecular sieve is selected from the group consisting of LTL, FAU, MOR, *BEA, MFI, MEL, MTW, MTT, MFS, FER, and TON.

6. The catalyst recited in Claim 4, wherein said molecular sieve is selected from the group consisting of zeolite L, zeolite X, zeolite

Y, mordenite, zeolite Beta, ZSM-5, ZSM-11, ZSM-22, silicalite 1 and silicalite 2.

7. The catalyst recited in Claim 3, wherein said crystalline molecular sieve is a ZSM-5 or silicalite 1.
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8. The catalyst recited in Claim 3, wherein said particles have an average particle size of less than 500 nm.
- 10 9. The catalyst recited in recited in Claim 3, wherein said particles are joined together as a result of the synthesis of the at least one macrostructure.
10. The catalyst in Claim 3, wherein said particles occupy less than 15 50% of the total volume of said macrostructures.
11. The catalyst recited in Claim 1, wherein said porous inorganic material is mesoporous inorganic material.
- 20 12. The catalyst recited in Claim 11, wherein said mesoporous inorganic material is selected from the group consisting of silica, aluminum silicate, alumina, MCM-41, and MCM-48.
13. The catalyst recited in Claim 3, wherein said at least one metal 25 is a hydrogenation/ dehydrogenation metal.
14. The catalyst recited in Claim 4, wherein said at least one metal is effective for reducing the strength of or the number of acid sites on said porous inorganic material.

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15. The catalyst recited in Claim 4, wherein said at least one macrostructure does not contain significant amounts of amorphous materials.

5 16. A process of preparing a catalyst comprising; at least one porous macrostructure comprised of: (a) a three-dimensional network of self bound particles of porous inorganic material; and, (b) at least one metal, said particles occupying less than 75% of the total volume of said at least one macrostructure and being joined together to form a three-dimensional interconnected network comprised of pores; which method comprises the steps of: (i) forming an admixture comprising, a porous organic ion exchanger and a synthesis mixture which occupies at least a portion of the pore space of said porous organic ion exchanger and is capable of forming said porous inorganic material; (ii) converting said synthesis mixture to said porous inorganic material; and, (iii) removing said porous organic ion exchanger;

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wherein said at least one metal is present in said admixture of step (i), or is added during the conversion of step, (ii), or is added to at least one macrostructure before the removal in step (iii) of the porous organic ion exchanger and after the formation in step (ii) of the porous inorganic material, or is added to said at least one macrostructure after the removal in step (iii) of the porous organic ion exchanger, or combinations thereof.

17. The process recited in Claim 16 wherein said porous inorganic material is comprised of molecular sieve.

18. The process recited in Claim 17, wherein said network comprises pores having diameters greater than about 20 Å.

19. The process recited in Claim 18, wherein said porous inorganic material is a large pore or intermediate pore size molecular sieve.

20. The process recited in Claim 19, wherein said porous organic ion exchanger is a porous polymer-based anionic exchanger.

21. The process recited in Claim 20, wherein said organic ion exchanger is a macroreticular ion exchanger.

22. The process recited in Claim 20, wherein the conversion of the synthesis mixture is carried out under hydrothermal conditions.

23. The process recited in Claim 21, wherein said porous polymer-based anionic ion-exchanger has an ion-exchange capacity greater than about 1 mEq./g of dry porous anionic ion-exchanger.

24. The process recited in Claim 20, wherein said porous polymer-based anionic ion-exchanger is a strongly basic anion-exchange resin containing quartenary ammonium groups.

25. The process recited in Claim 21, wherein the structure type of said molecular sieve is selected from the group consisting of LTL, FAU, MOR, *BEA, MFI, MEL, MTW, MTT, MFS, FER, and TON.

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26. The process recited in Claim 25, wherein said porous organic ion exchanger is removed by either an oxidation process or dissolution.

5 27. The process recited in Claim 25, wherein said at least one metal is present on the porous organic ion exchanger before forming the synthesis mixture of step (i).

10 28. The process recited in Claim 25, wherein said at least one metal is included in the porous organic ion exchanger by deposition, adsorption, or ion exchange.

15 29. The process recited in Claim 25, wherein the at least one metal is added to said admixture of step (i) during the preparation, after the formation, or both, of said admixture.

30. The process recited in Claim 25, wherein said at least one metal is added during the conversion of step (ii).

20 31. The process recited in Claim 25, wherein said at least one metal is added to the at least one macrostructure before the removal in step (iii) of the porous organic ion exchanger and after the formation in step (ii) of the porous inorganic material.

25 32. The process recited in Claim 25, wherein said at least one metal is added to said at least one macrostructure after the removal in step (iii) of the porous organic ion exchanger.

30 33. The process recited in Claim 25, wherein said macrostructures have at least one dimension greater than about 1.0 mm.

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34. The process recited in Claim 25, wherein said at least one macrostructure does not contain significant amounts of amorphous materials.

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35. The process recited in Claim 25, wherein said at least one macrostructure has a density of less than 0.50 g/cc.

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36. The process recited in Claim 25, wherein said particles are joined together by means other than by physical binding of the particles.

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37. The process recited in Claim 25, wherein said at least one metal is a hydrogenation/ dehydrogenation metal.

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38. The process recited in Claim 25, said at least one metal is effective for reducing the strength of or the number of acid sites on said porous inorganic material.

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39. The process recited in Claim 16, wherein said porous inorganic material is mesoporous inorganic material.

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40. The process recited in Claim 39, wherein said mesoporous inorganic material is selected from the group consisting of silica, aluminum silicate, alumina, MCM-41, and MCM-48.

41. The process recited in Claim 17, wherein said particles occupy less than 50% of the total volume of said macrostructures.

42. A process for converting hydrocarbons comprising contacting a hydrocarbon feedstream under hydrocarbon conversion conditions with a catalyst comprising:

5 at least one porous macrostructure comprised of: (a) a three-dimensional network of self bound particles of porous inorganic material; and, (b) at least one metal, said particles occupying less than 75% of the total volume of said at least one macrostructure and being joined together to form a three-dimensional interconnected network of pores.

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15 43. The process recited in Claim 42 wherein said catalyst is prepared by a process comprising the steps of: (i) forming an admixture comprising, a porous organic ion exchanger and a synthesis mixture which occupies at least a portion of the pore space of said porous organic ion exchanger and is capable of forming said porous inorganic material; (ii) converting said synthesis mixture to said porous inorganic material; and, (iii) removing said porous organic ion exchanger;

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25 wherein said at least one metal is present in said admixture of step (i), or is added during the conversion of step, (ii), or is added to at least one macrostructure before the removal in step (iii) of the porous organic ion exchanger and after the formation in step (ii) of the porous inorganic material, or is added to said at least one macrostructure after the removal in step (iii) of the porous organic ion exchanger, or combinations thereof.

30 44. The process recited in Claim 42 wherein the hydrocarbon conversion is carried out at conditions of about 0°C to about

760°C, a pressure of from about 0.1 atmosphere (bar) to about 200 atmospheres (bar), a weight hourly space velocity of from about 0.08hr⁻¹ to about 2,000hr⁻¹.

5 45. The process recited in Claim 44, wherein said catalyst is prepared the hydrocarbon conversion is selected from the group consisting of cracking of hydrocarbons, isomerization of alkyl aromatics, disproportionation of toluene, disproportionation of cumene and ethylbenzene, transalkylation of aromatics, 10 alkylation of aromatics, alkylation of naphthalene or alkyl naphthalene to form dialkyl naphthalene, reforming of naphtha to aromatics, conversion of paraffins and/or olefins to aromatics, conversion of oxygenates to hydrocarbon products, cracking of naphtha to light olefins, and dewaxing of hydrocarbons.

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46. The process recited in Claim 44, wherein said porous inorganic material is mesoporous inorganic material.

20 47. The process recited in Claim 44, wherein said porous inorganic material is comprised of molecular sieve.

48. The process recited in Claim 47, wherein said network comprises pores having diameters greater than about 20 Å.

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49. The process recited in Claim 47, wherein said porous inorganic material is a large pore or intermediate pore size molecular sieve.

50. The process recited in Claim 49, wherein the structure type of said molecular sieve is selected from the group consisting of LTL, FAU, MOR, *BEA, MFI, MEL, MTW, MTT, MFS, FER, and TON.

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51. The process recited in Claim 43, wherein the structure type of said molecular sieve is selected from the group consisting of LTL, FAU, MOR, *BEA, MFI, MEL, MTW, MTT, MFS, FER, and TON.

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52. The process recited in Claim 51, wherein said at least one metal is present on the porous organic ion exchanger before forming the synthesis mixture of step (i).

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53. The process recited in Claim 51, wherein said at least one metal is included in the porous organic ion exchanger by deposition, adsorption, or ion exchange.

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54. The process recited in Claim 51, wherein the at least one metal is added to said admixture of step (i) during the preparation, after the formation, or both, of said admixture.

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55. The process recited in Claim 51, wherein said at least one metal is added to the at least one macrostructure before the removal in step (iii) of the porous organic ion exchanger and after the formation in step (ii) of the porous inorganic material.

56. The process recited in Claim 51, wherein said macrostructures have at least one dimension greater than about 1.0 mm.

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57. The process recited in Claim 51, wherein said porous organic ion exchanger is a porous polymer-based anionic exchanger.

58. The process recited in Claim 57, wherein said porous polymer-based anionic ion-exchanger has an ion-exchange capacity greater than about 1 mEq./g of dry porous anionic ion-exchanger.

59. The process recited in Claim 44, wherein said hydrocarbon conversion comprises the partial oxidizing hydrocarbons by contacting a hydrocarbon feedstream under oxidation conditions with oxidants.

60. The process recited in Claim 59, wherein said oxidants are selected from the group consists of air, oxygen, organic peroxides, inorganic oxides.

61. The process of Claim 60, wherein said hydrocarbon feedstream is selected from the group consists of paraffins, olefins, aromatics, and mixtures thereof.

20 62. A process for reducing emissions of hydrocarbons, carbon monoxide, oxides of nitrogen, or mixtures thereof in a gas stream comprising contacting said gas stream with a catalyst comprising:

25 at least one porous macrostructure comprised of: (a) a three-dimensional network of self bound particles of porous inorganic material; and, (b) at least one metal, said particles occupying less than 75% of the total volume of said at least one

macrostructure and being joined together to form a three-dimensional interconnected network of pores.

63. The process recited in Claim 62, wherein said gas stream is a
5 gas stream produced by an internal combustion engine.

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